A PROPOSED LANDING SITE FOR THE 2020 MARS MISSION: FIRSOFF CRATER

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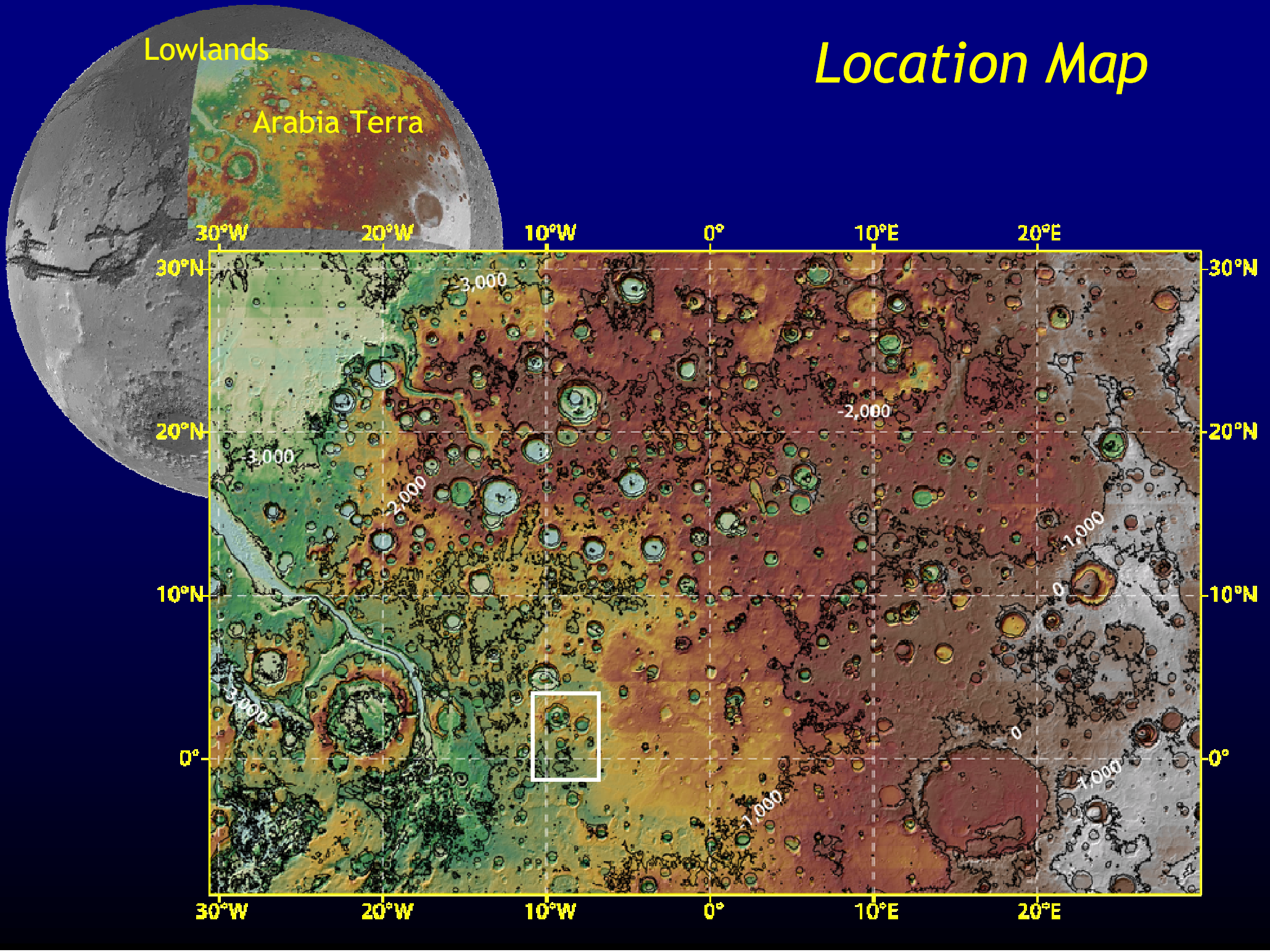
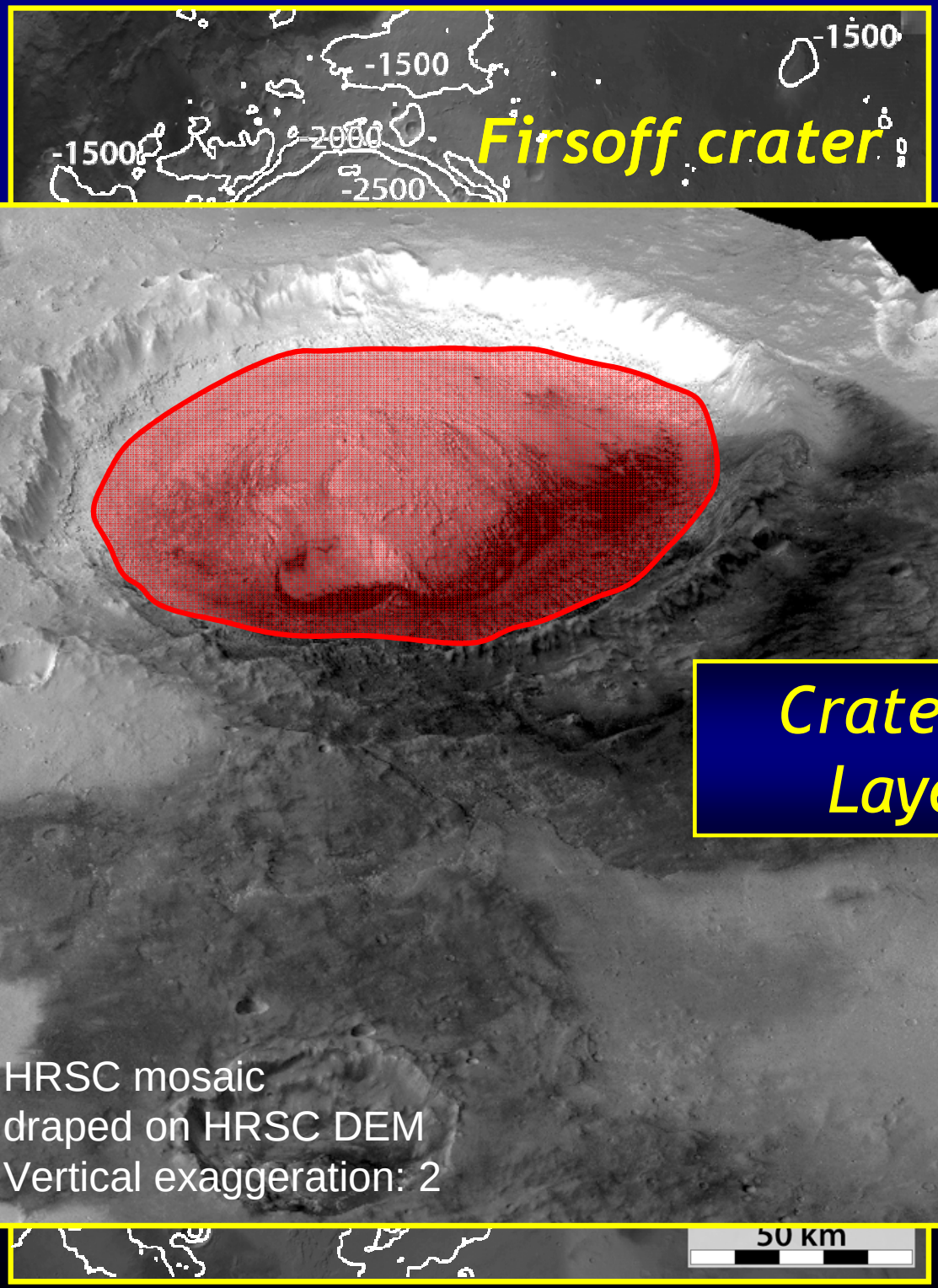
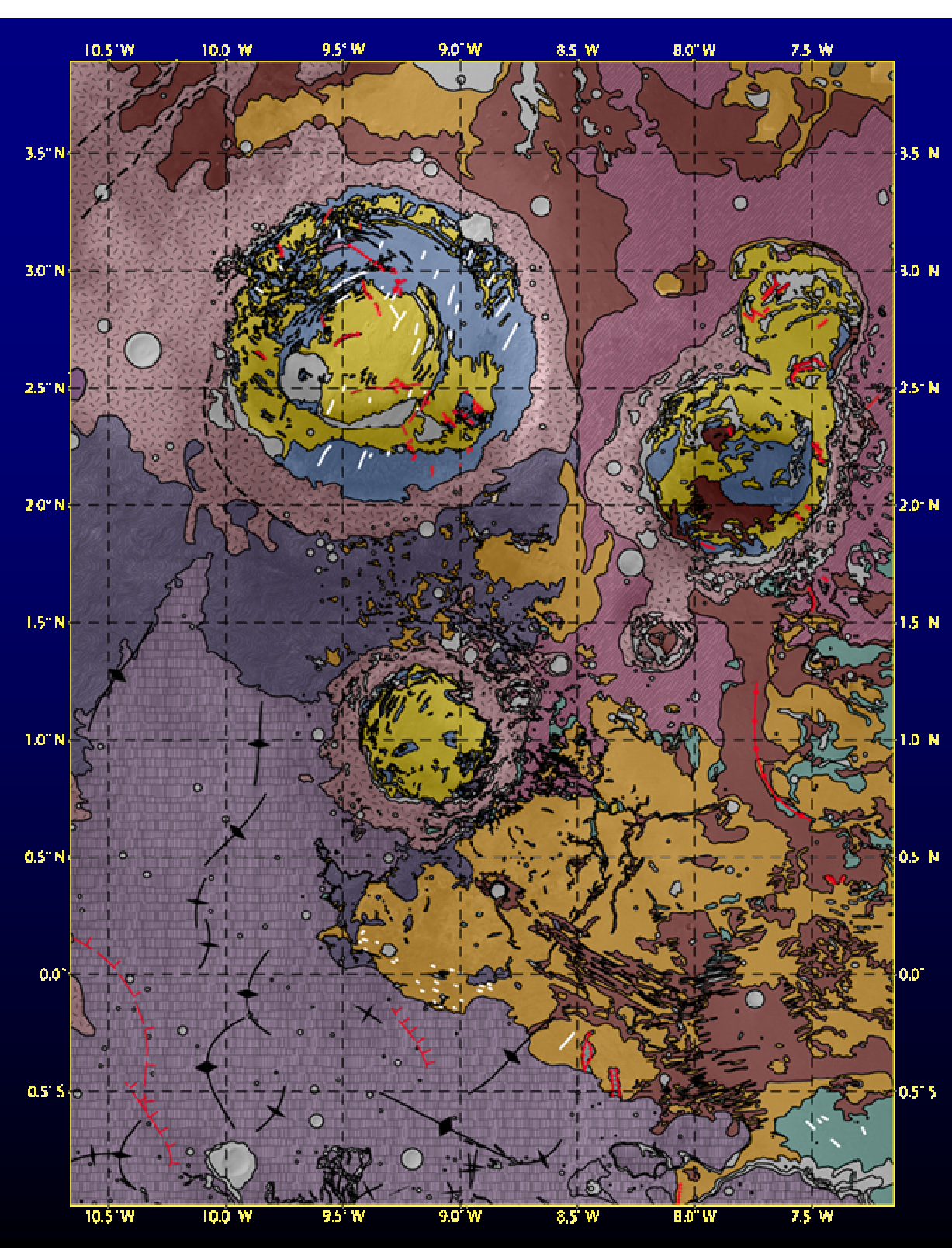

Lowlands
Arabia Terra
Location Map
30°W
20°W
10°W
0°
10°E
20°E
30°N
20°N
10°N
0°
-3,000
-2,000
-1,000
0
1,000

Geography


-1500
-1500
-1500
-2000
-2500
Firsoff crater
N
Crater bulge --> Equatorial Layered Deposits (ELDs)
HRSC mosaic
draped on HRSC DEM
Vertical exaggeration: 2
~40 km
50 km

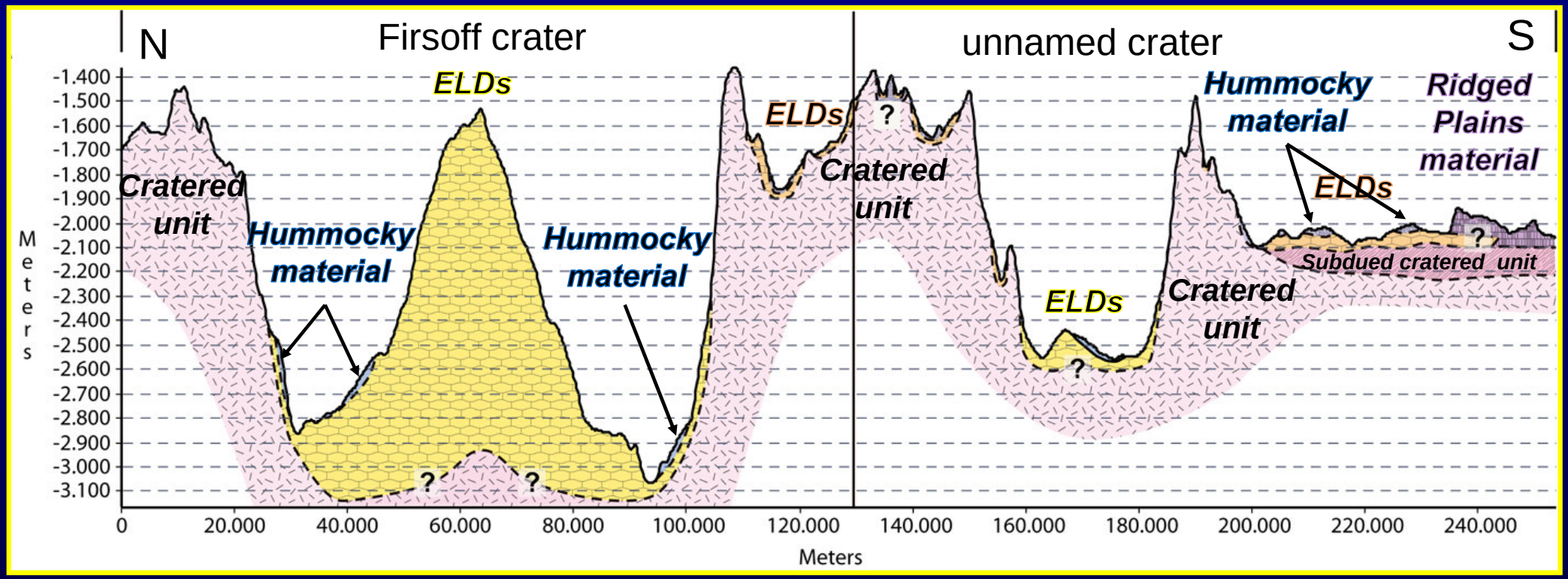


Geological Map

- Aeolian / mass wasting / impact craters
- Mantling
- RIDGED PLAINS MATERIAL
- Hummocky Material
- MOUNDS within ELDs *inside the craters*
- MOUNDS within ELDs *outside the craters*
- EQUATORIAL LAYERED DEPOSITS (ELDs) *inside the craters*
- EQUATORIAL LAYERED DEPOSITS (ELDs) *outside the craters*
- PLATEAU SEQUENCE - Subdued cratered
- PLATEAU SEQUENCE - Cratered unit

- Yardang
- Fissure ridge
- Fault / fracture
- Lava front
- Wrinkle ridge

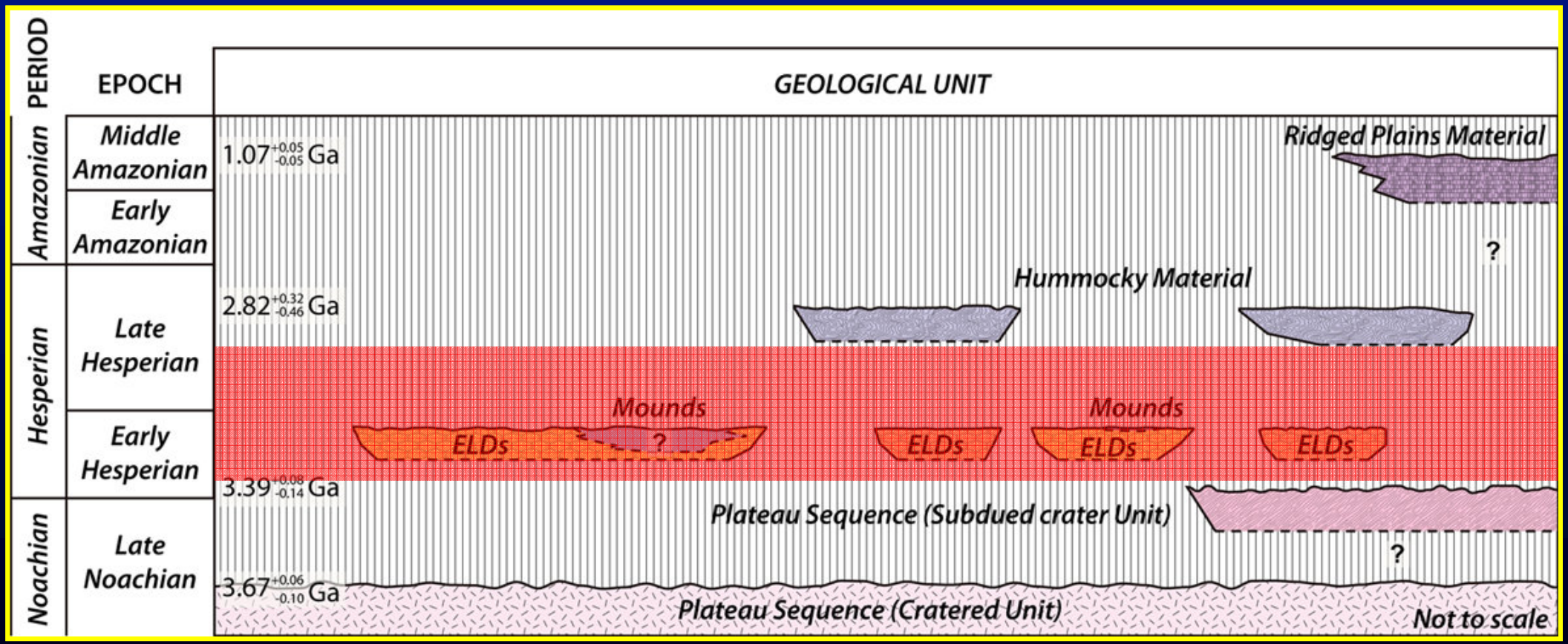
Geological section



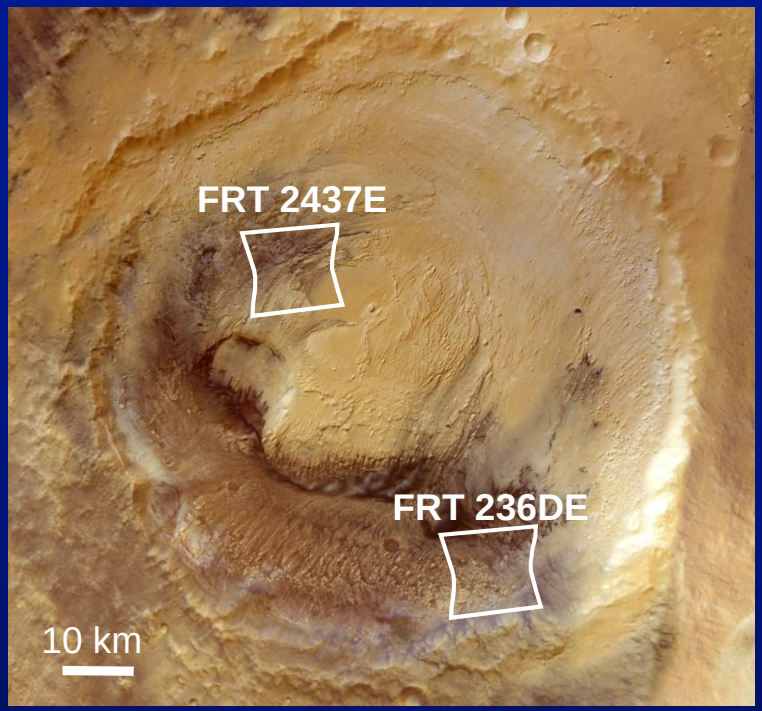
ELDs form bulges in the craters (thicknesses up to 2 km) and a sheet drape geometry on the plateaus

Stratigraphic framework

ELDs deposition constrained between the Early and lower part of the Late Hesperian

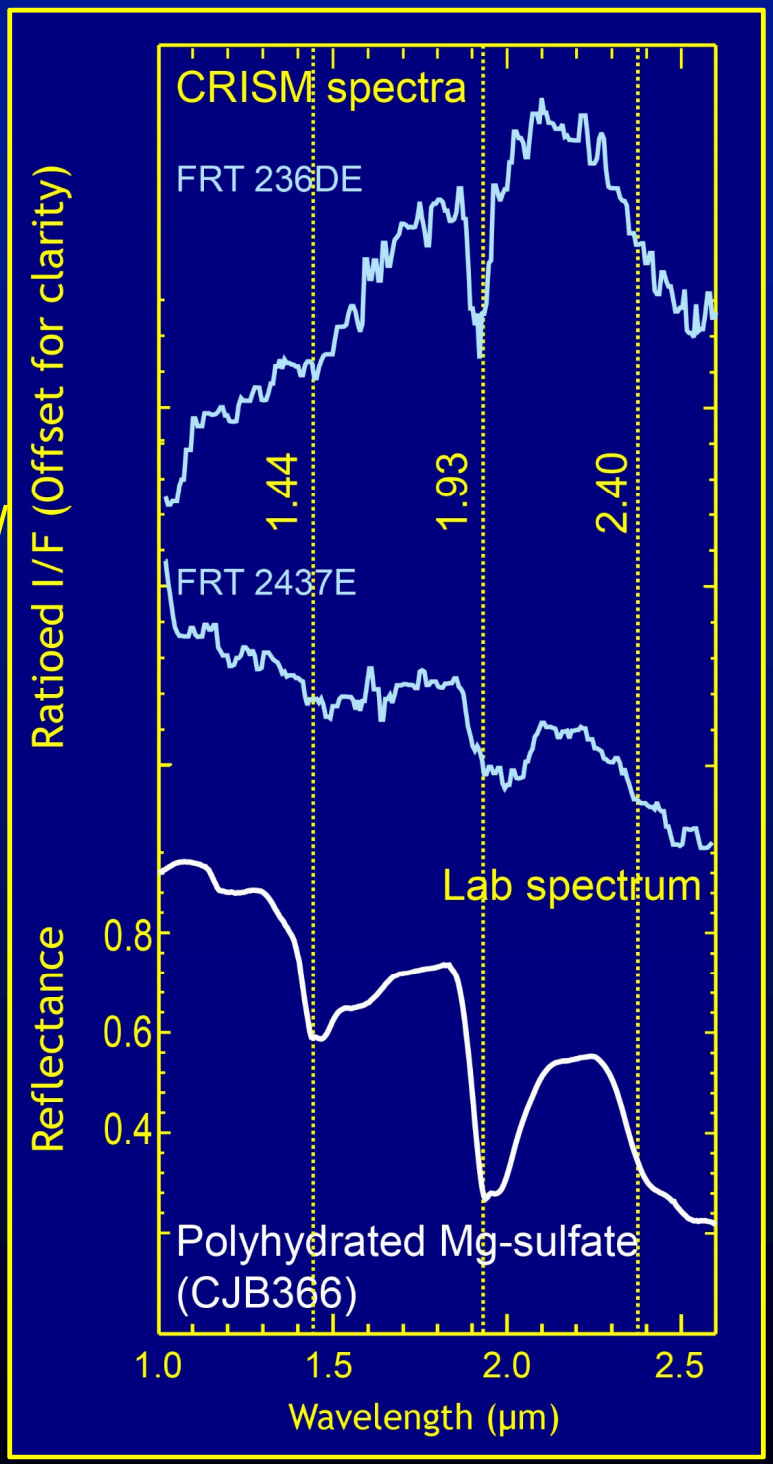


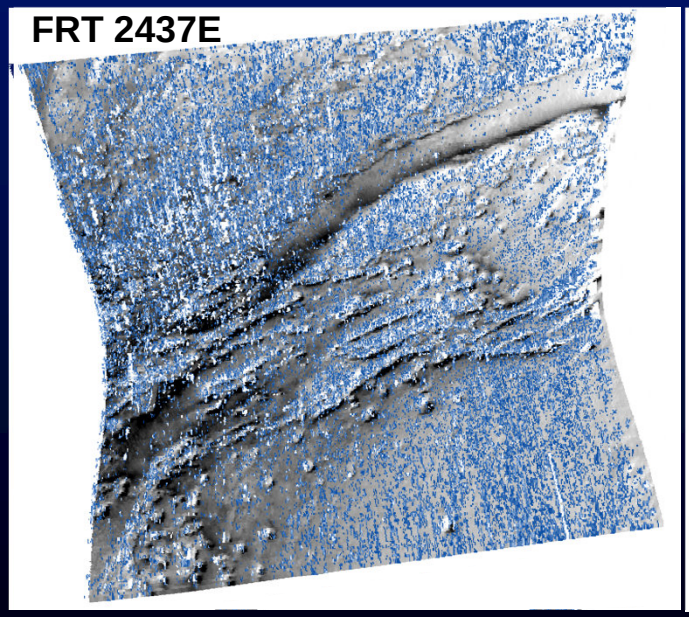
Mineralogical composition

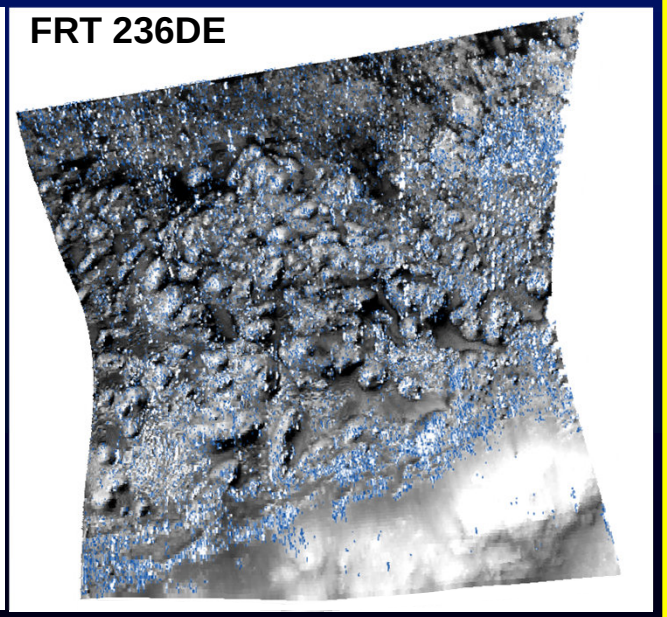


Firsoff crater

Hydrous minerals consistent with polyhydrated sulfates/ zeolites

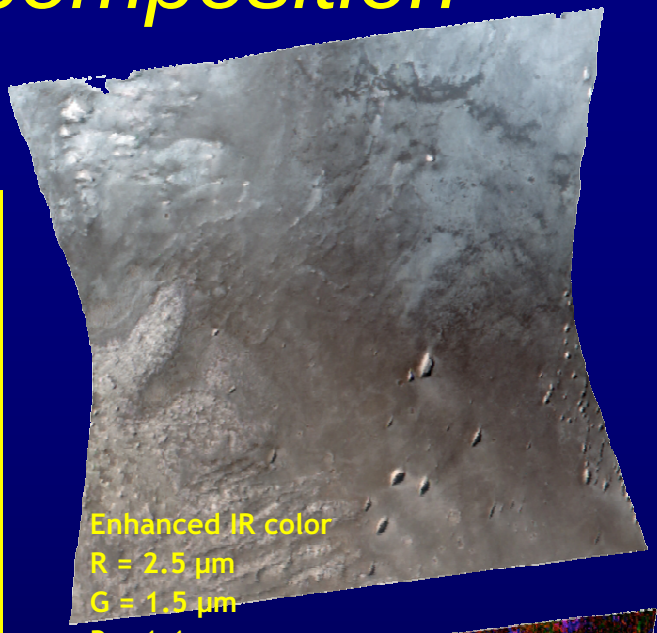


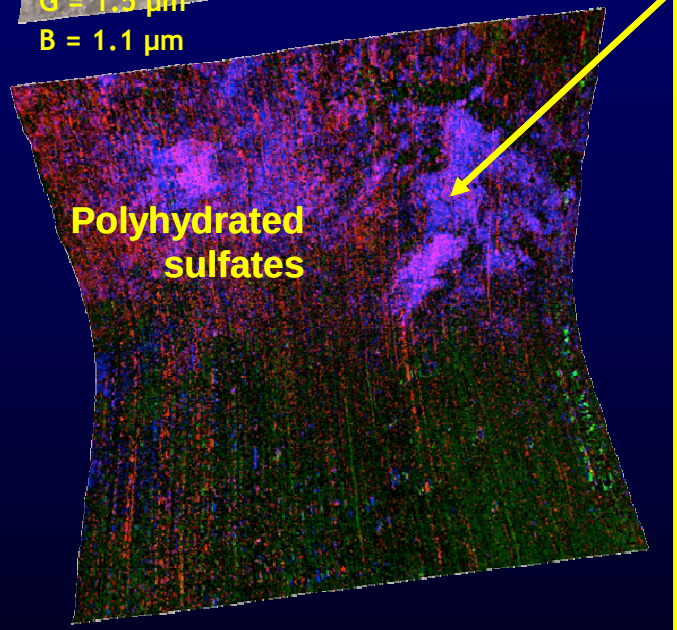




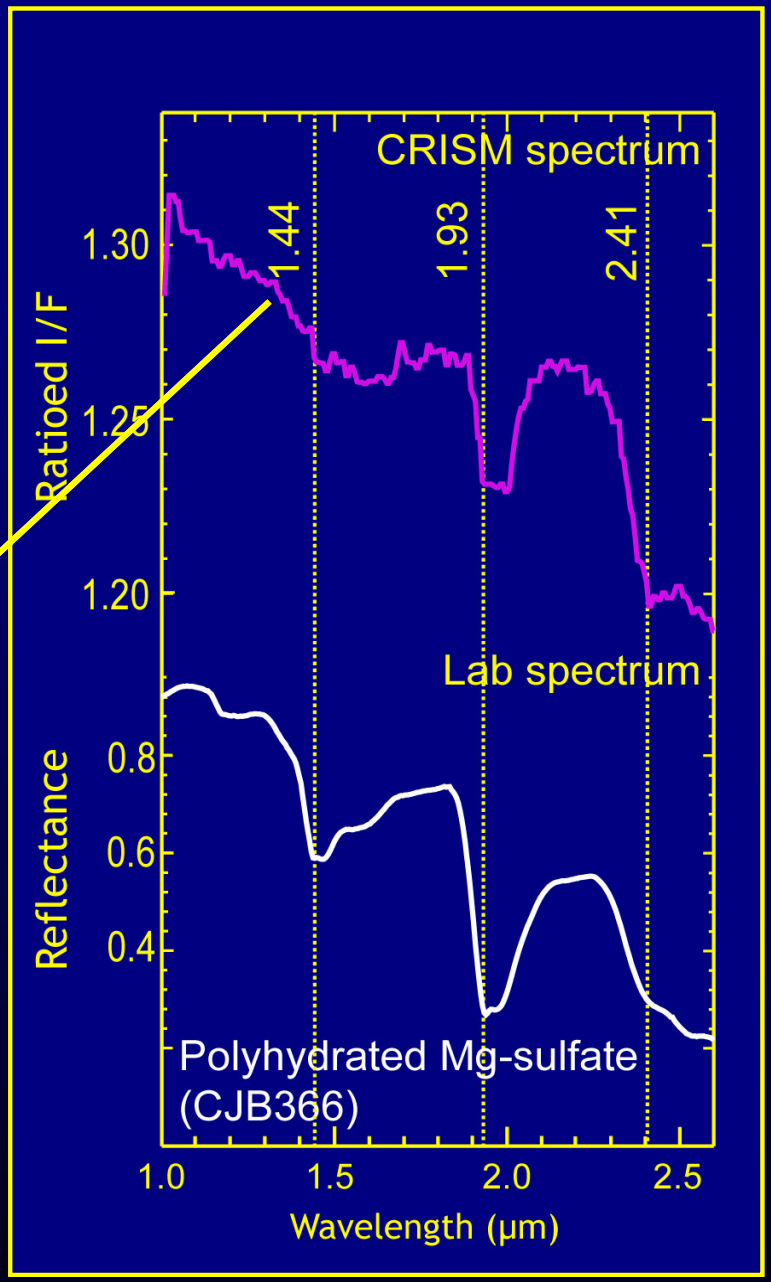
Albedo CRISM images overlain by 1.9-μm band depth maps

Mineralogical composition



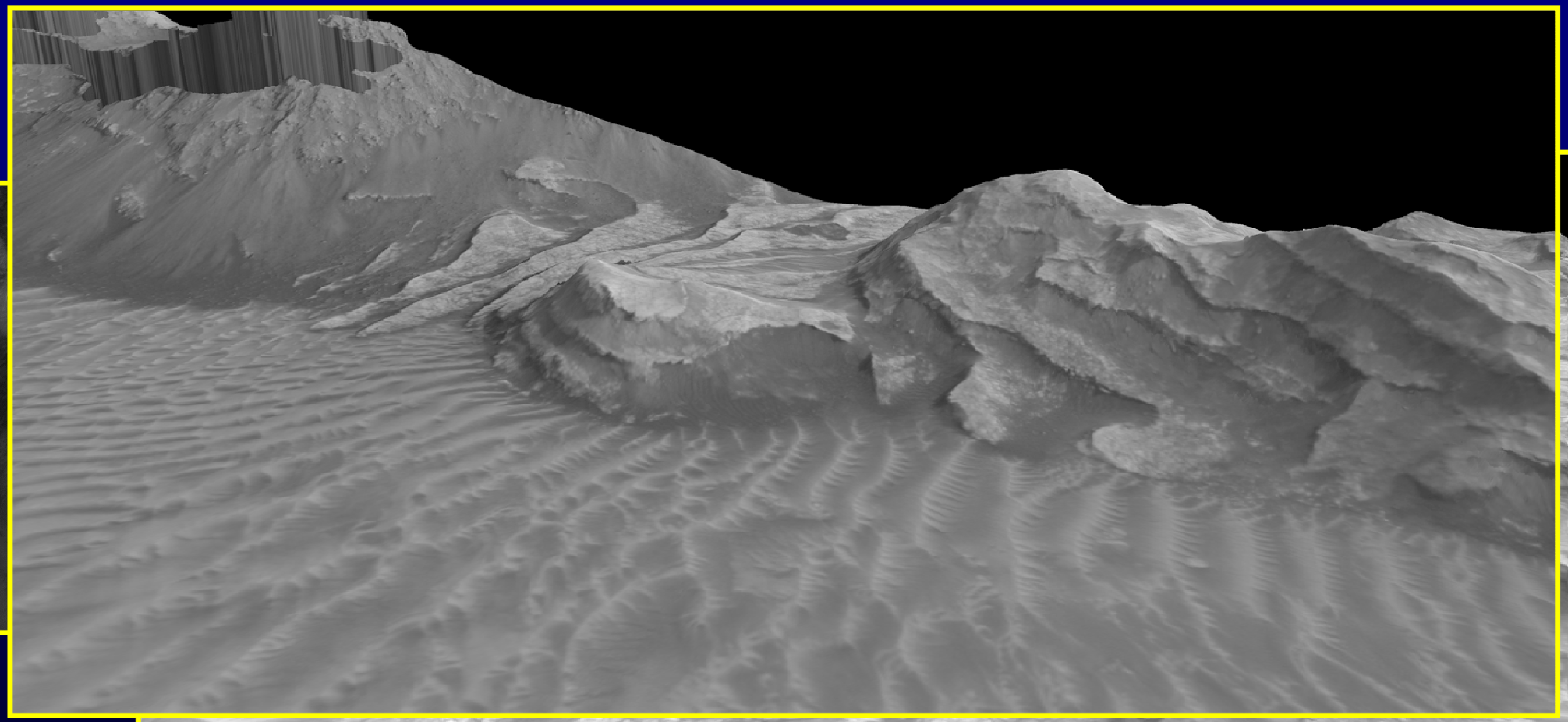


Spectral parameter map
R = 2.4-μm band depth (SINDEX; 0.037/0.054)
G = 2.1-μm band depth (BD2100; 0.009/0.076)
B = 1.9-μm band depth (BD1900R; 0.014/0.024)



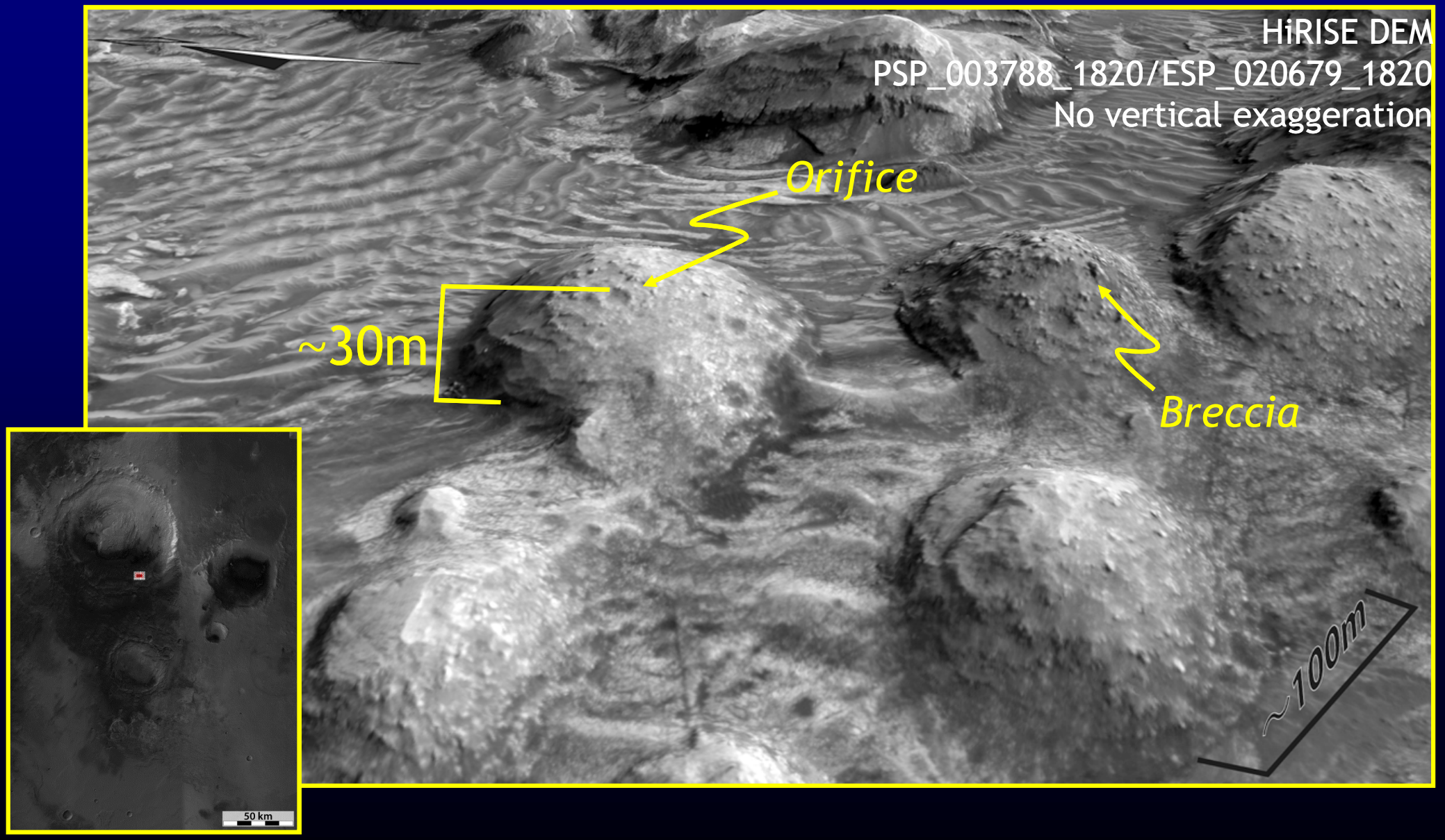
Polyhydrated sulfates also detected on other ELDs

Facies of the ELDs inside craters
--> Layered unit



Layers drape the older succession.
No evidence of cross stratification.

Facies of the ELDs inside craters
-→ Mounds



Morphologies → Mounds

50 m

HiRISE PSP_003788_1820_RED
Res. 0.25 m/pix

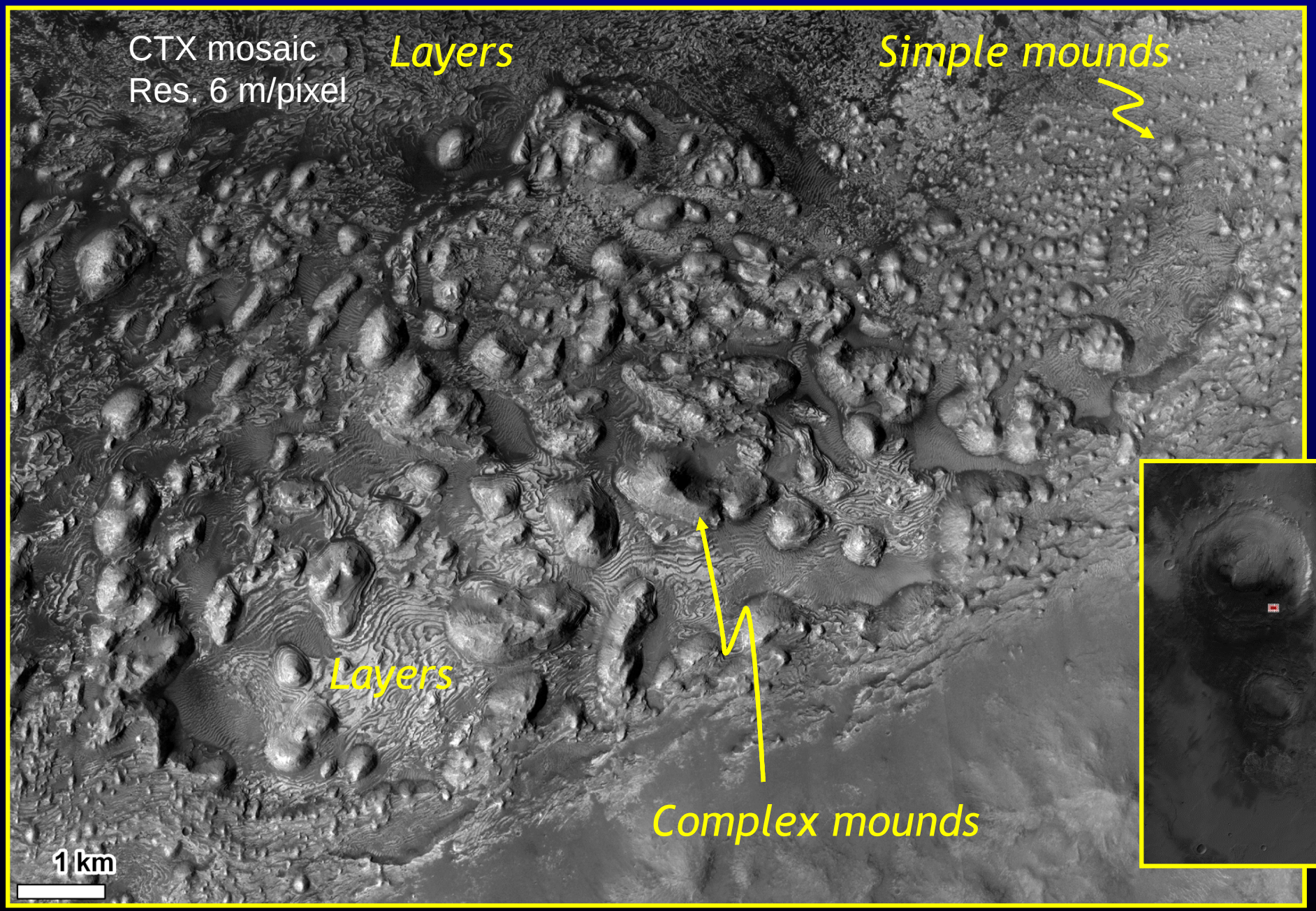
Orifice

Breccia

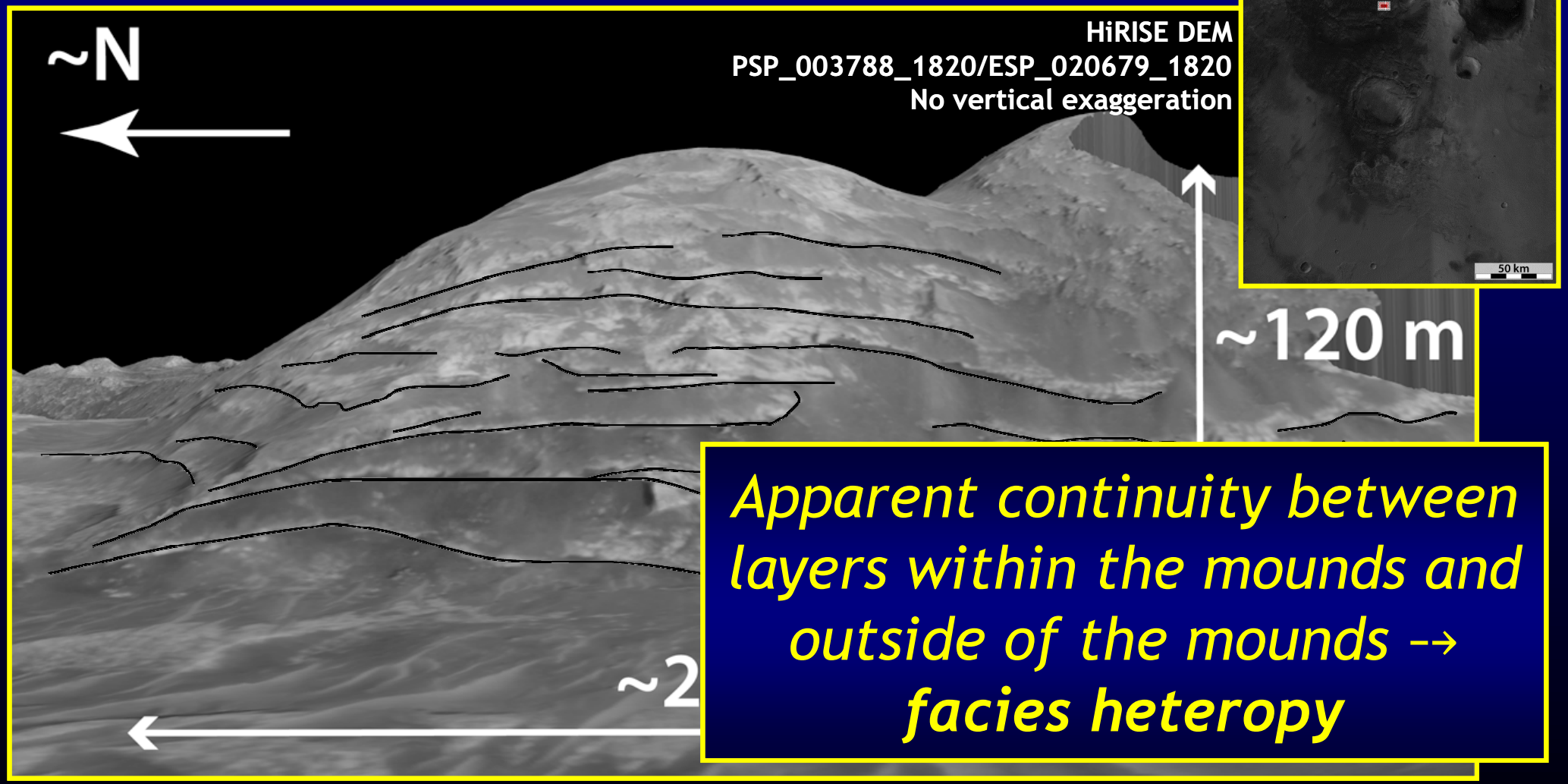
Polygonal pattern

Pondrelli et al., 2011

Morphologies --> Fields of mounds

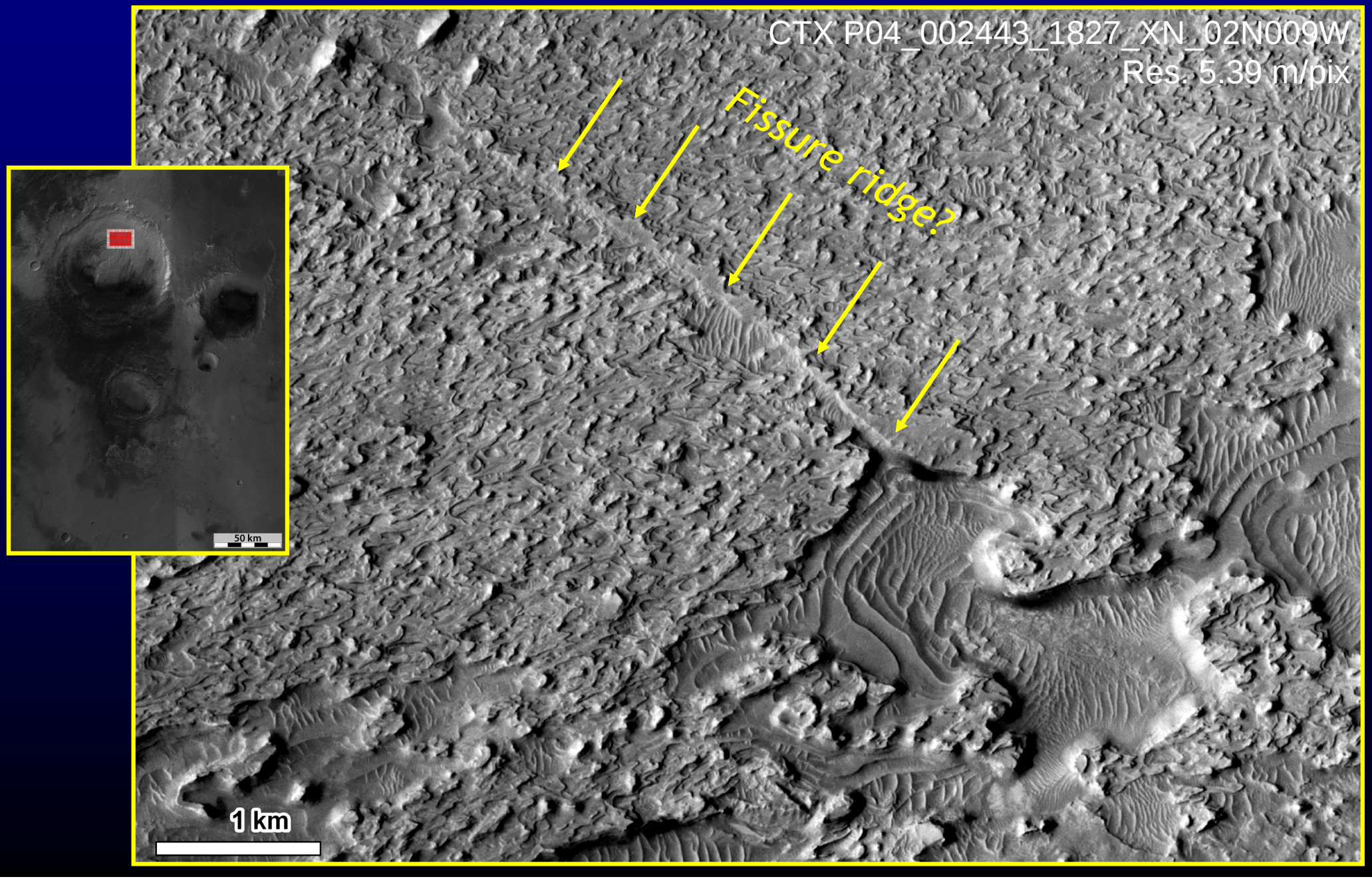


Depositional geometries and stratigraphy

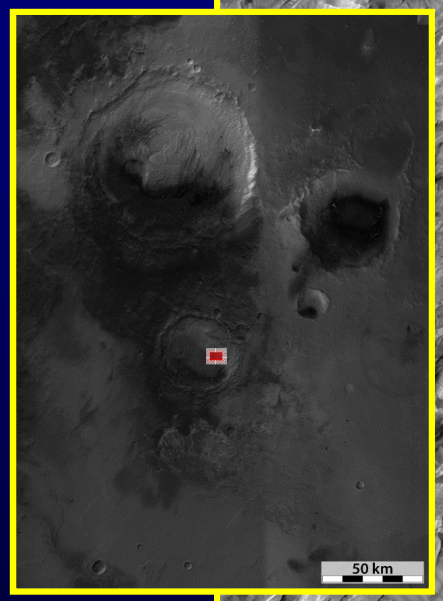


Apparent continuity between layers within the mounds and outside of the mounds → ***facies heteropy***

Morphologies --> Fissure ridges



Morphologies --> Fissure ridges and mounds aligned along fractures



Fissure ridge?

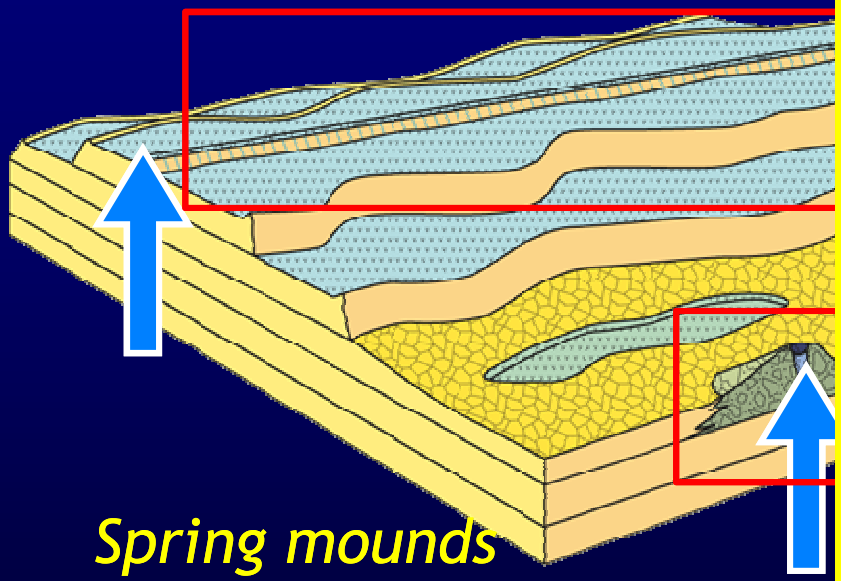
Mounds aligned along the fracture

1 km

HiRISE ESP_016921_1810_RED
Res. 0.55 m/pix

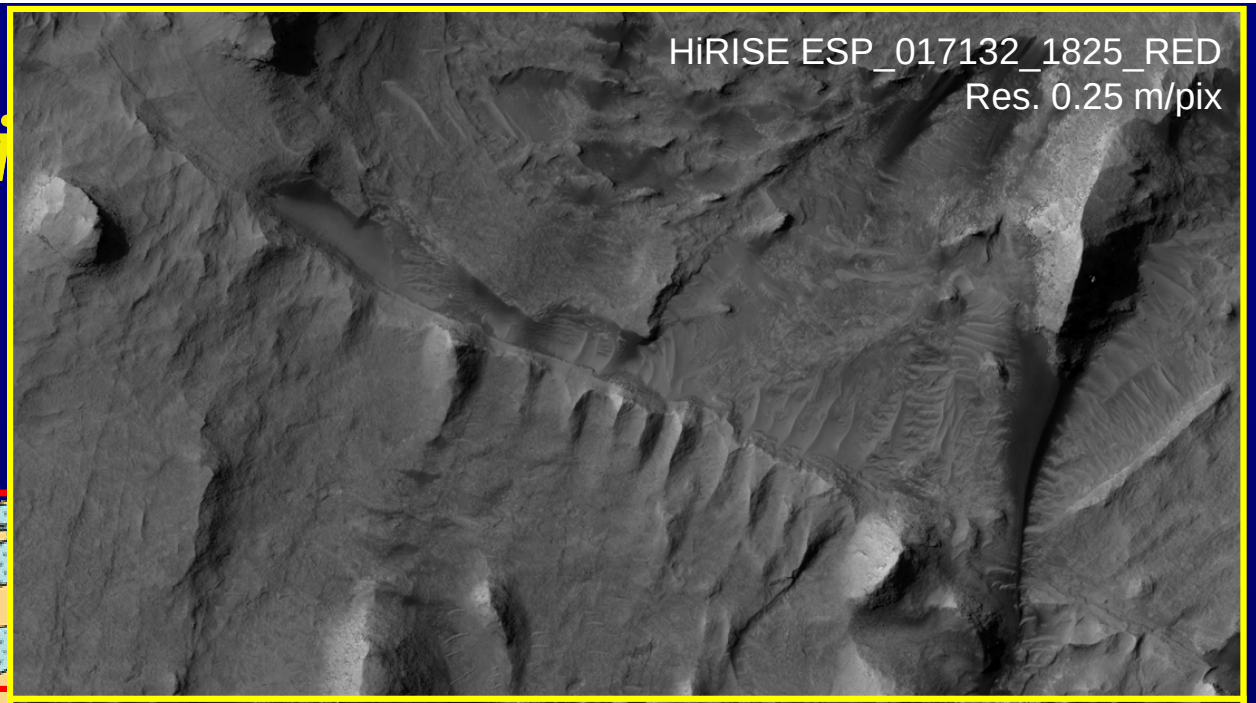
Interpretati

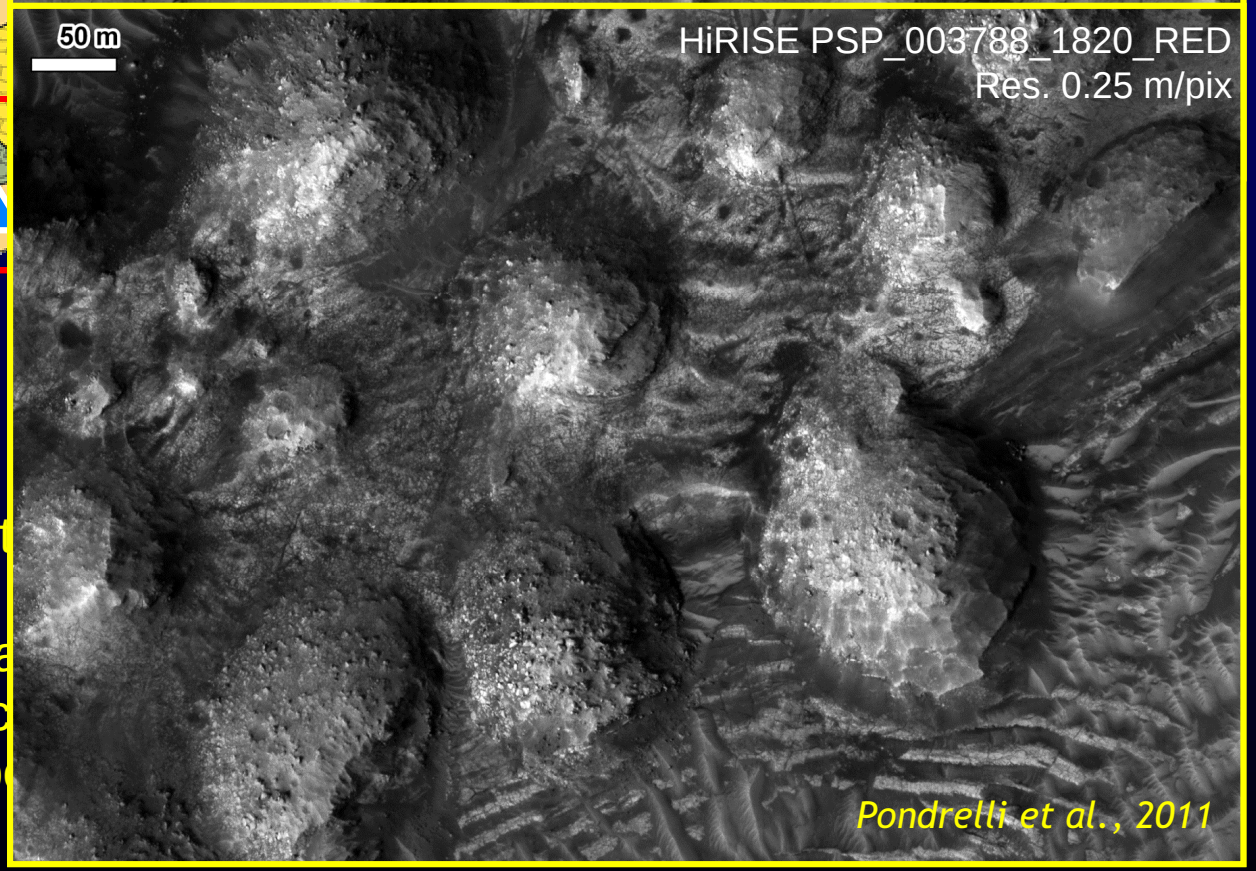
Fissure ridges



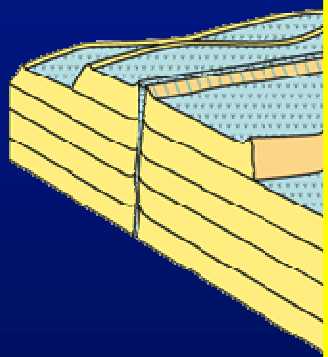
Spring mounds

The Firsoff crater ELDs might have
- the large scale geometry (bulge wit
peak of the crater);
- morphologies suggesting fluid esca
- composition and sedimentary struc
- morphologies consistent with evap





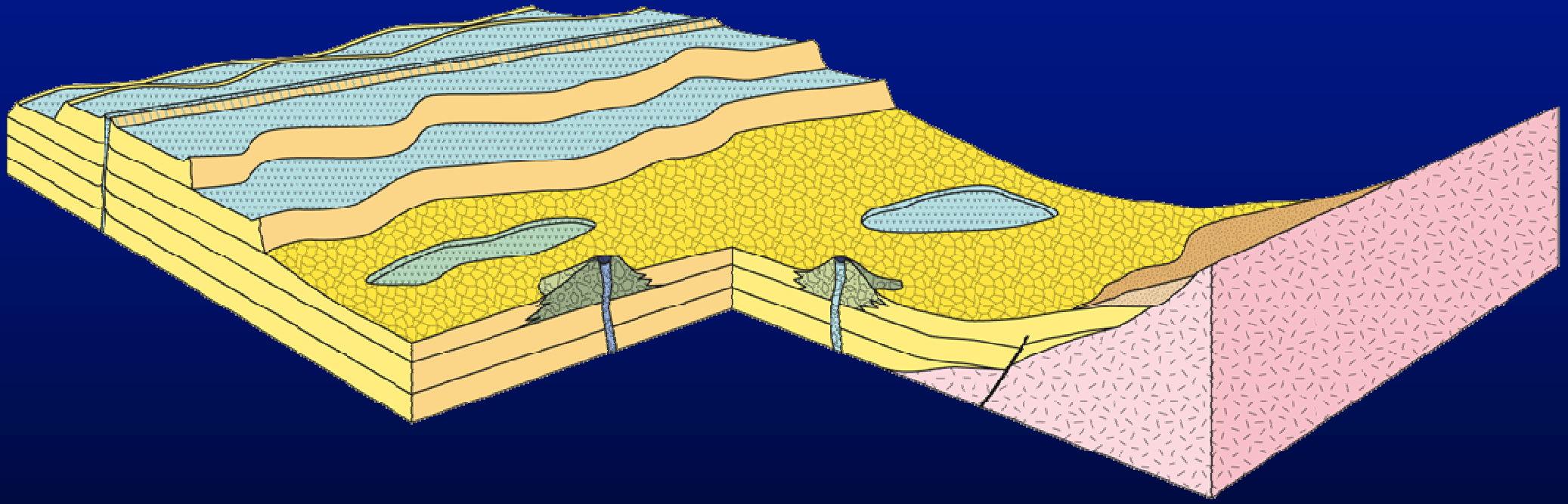
Interpretative scenario inside craters



Spring

The Firsoff c
✓ the large s
peak of the c
✓ morphologi
✓ compositio
✓ morphologi

Interpretative scenario inside craters



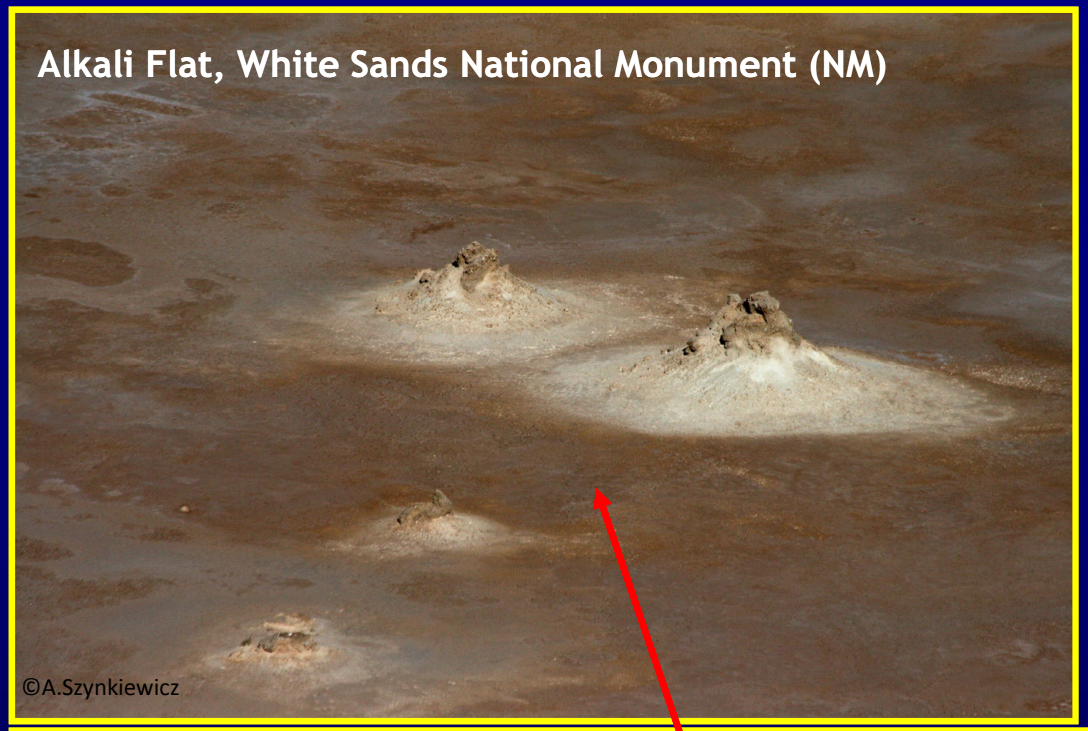
The Firsoff crater ELDs might have been formed as spring deposits because of:

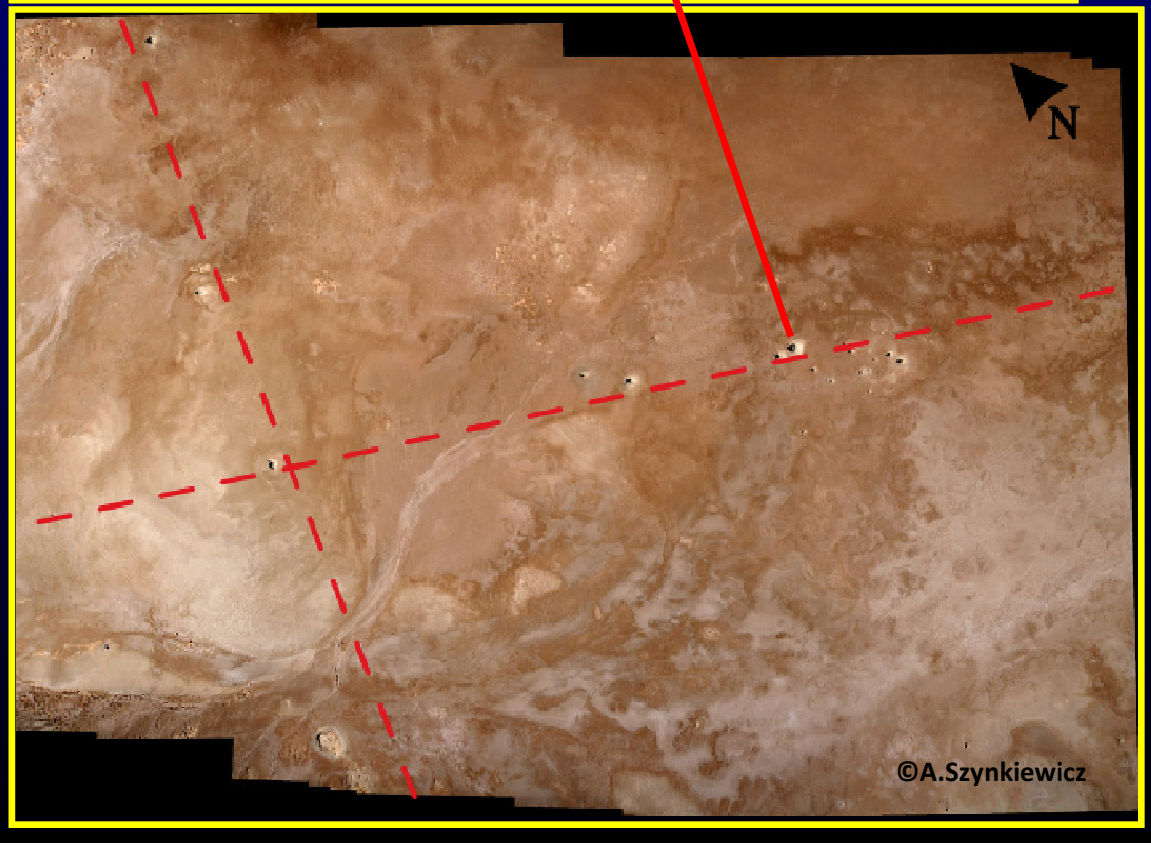
✓ the large scale geometry (bulge with maximum thickness roughly on top of the central peak of the crater);

✓ morphologies suggesting fluid escape (fissure ridges and spring mound);

✓ composition and sedimentary structures consistent with evaporite precipitation;

✓ morphologies consistent with evaporite composition.





Possible Earth analogues and biosignatures

Dome-like structures along the western margin of the Alkali Flat (a modern playa system at the western part of the monument) (Szynkiewicz et al. 2010).

The domes are of Pleistocene age, formed within lacustrine environment.

The alignment of domes suggests that groundwater upwelling was controlled by the fractures beneath the surface of Alkali Flat, which are associated with regional faulting.

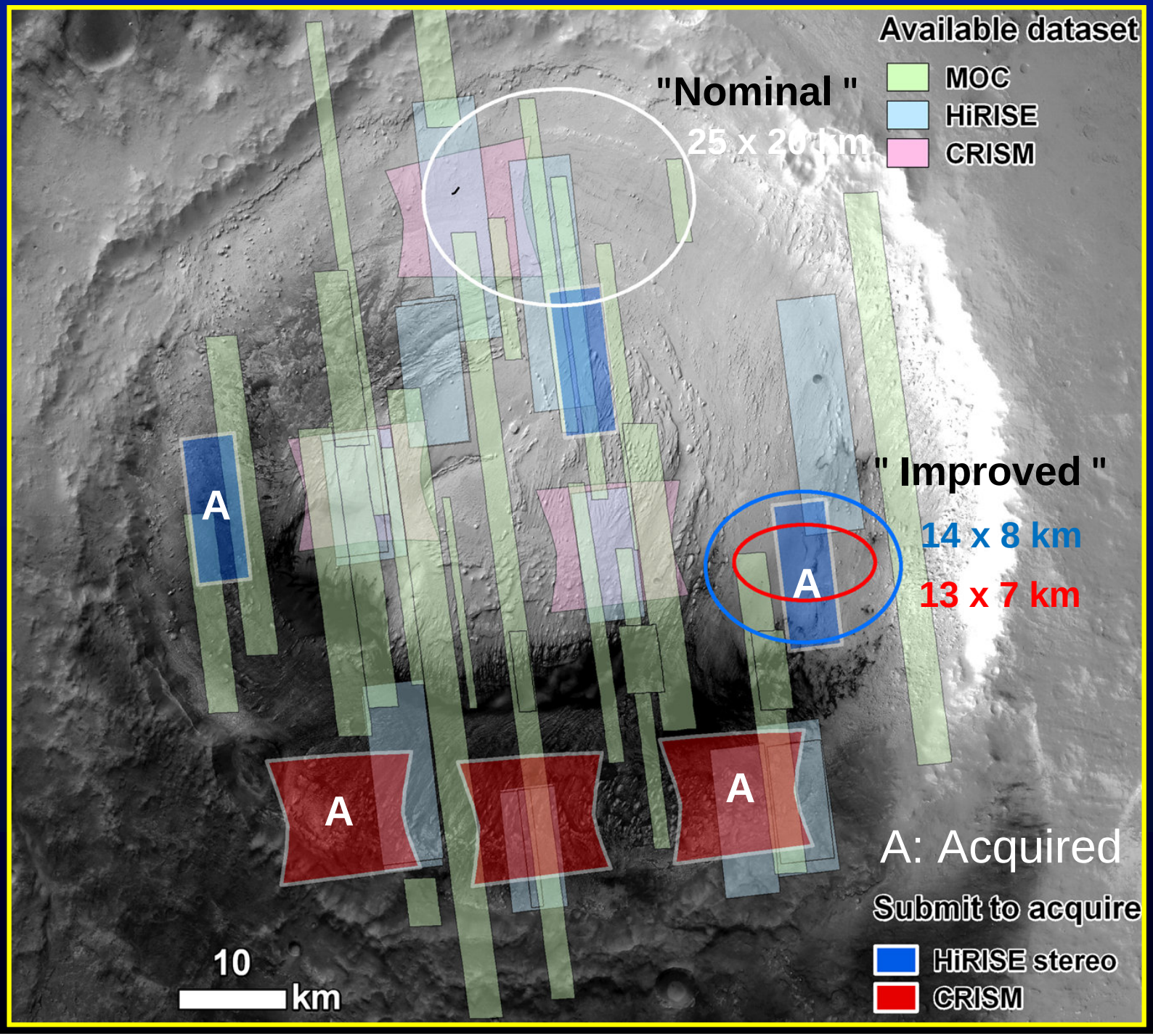
Composition --> Mg, Na and Ca sulphates

Habitability Potential

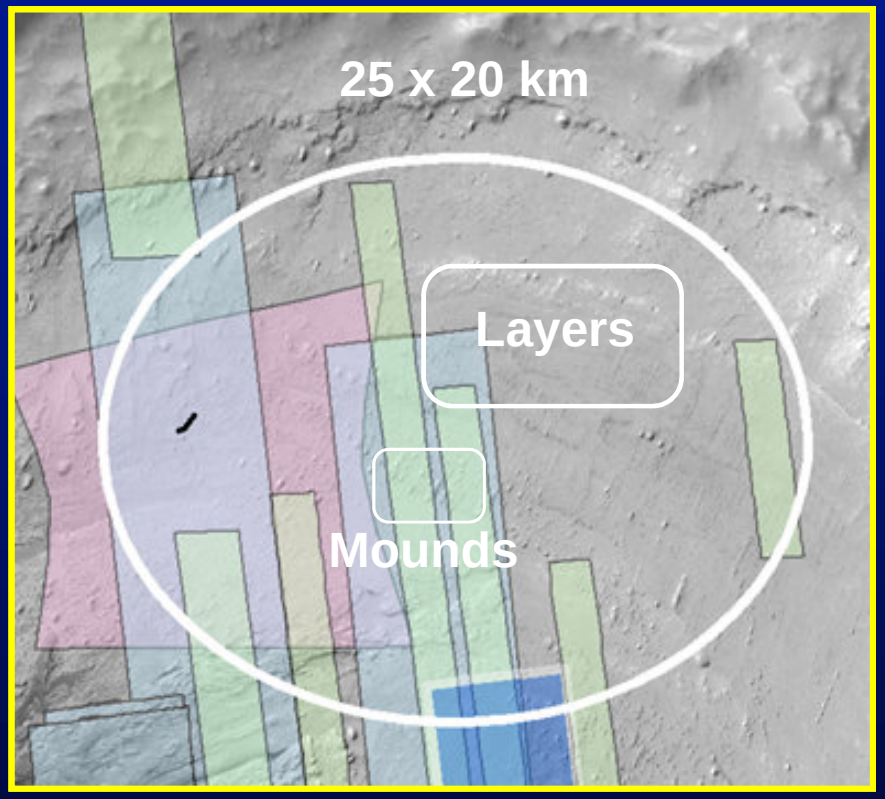
- ✓ *Spring deposits are potentially suitable targets when searching for life or traces of life (e.g., Walter and Des Marais, 1993; Cady and Farmer, 2007; Cavalazzi et al., 2007);*

- ✓ *Besides the fact that the presence of sulfates indicate potential existence of habitable conditions, sulfates have a good potential to preserve life traces (Panieri et al., 2010).*

Proposed landing ellipses



Proposed landing ellipses —> nominal landing ellipse

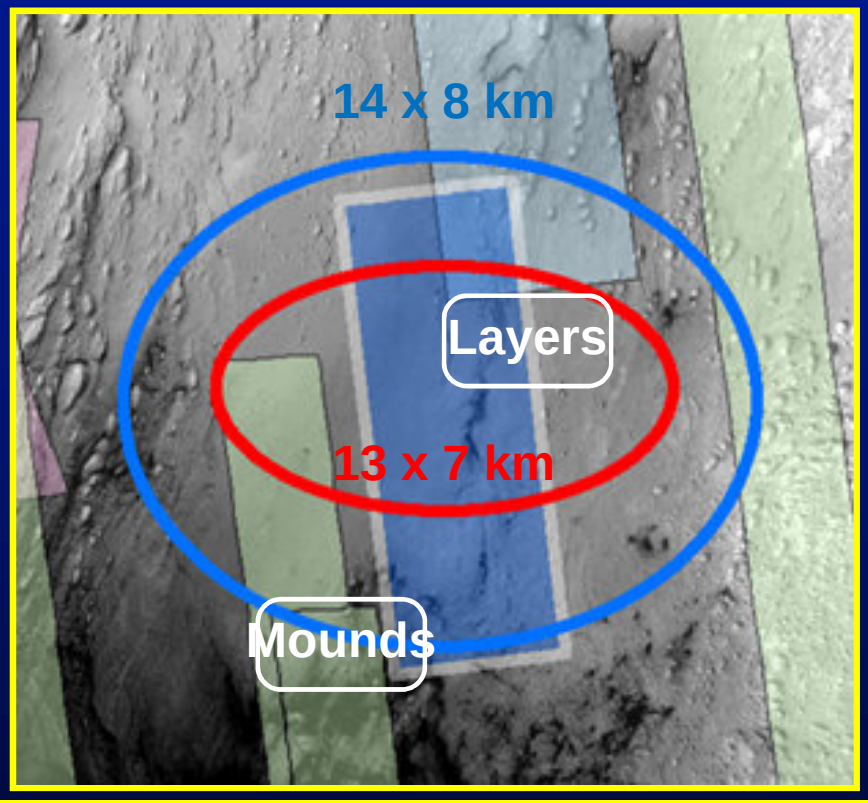


White ellipse (nominal landing ellipse)

Site Name	Firsoff crater
Center Coordinates Latitude, longitude	3.13 °N, 9.32°W
Elevation	-2743 m wrt MOLA
Prime Science and/or Sampling Targets	ELDs (spring deposits) Sulfates
Distance of Science and/ or Sampling Targets from Ellipse Center	Sulfates – 2.3 km to NE Layers – 2.3 km to NE Mounds – 1.9 km to SSW

Layers should be few meters thick, but this esteem reflects data from other parts in the crater.
Mounds are less abundant than in the south, but still present.

Proposed landing ellipses —> potential improved landing ellipses

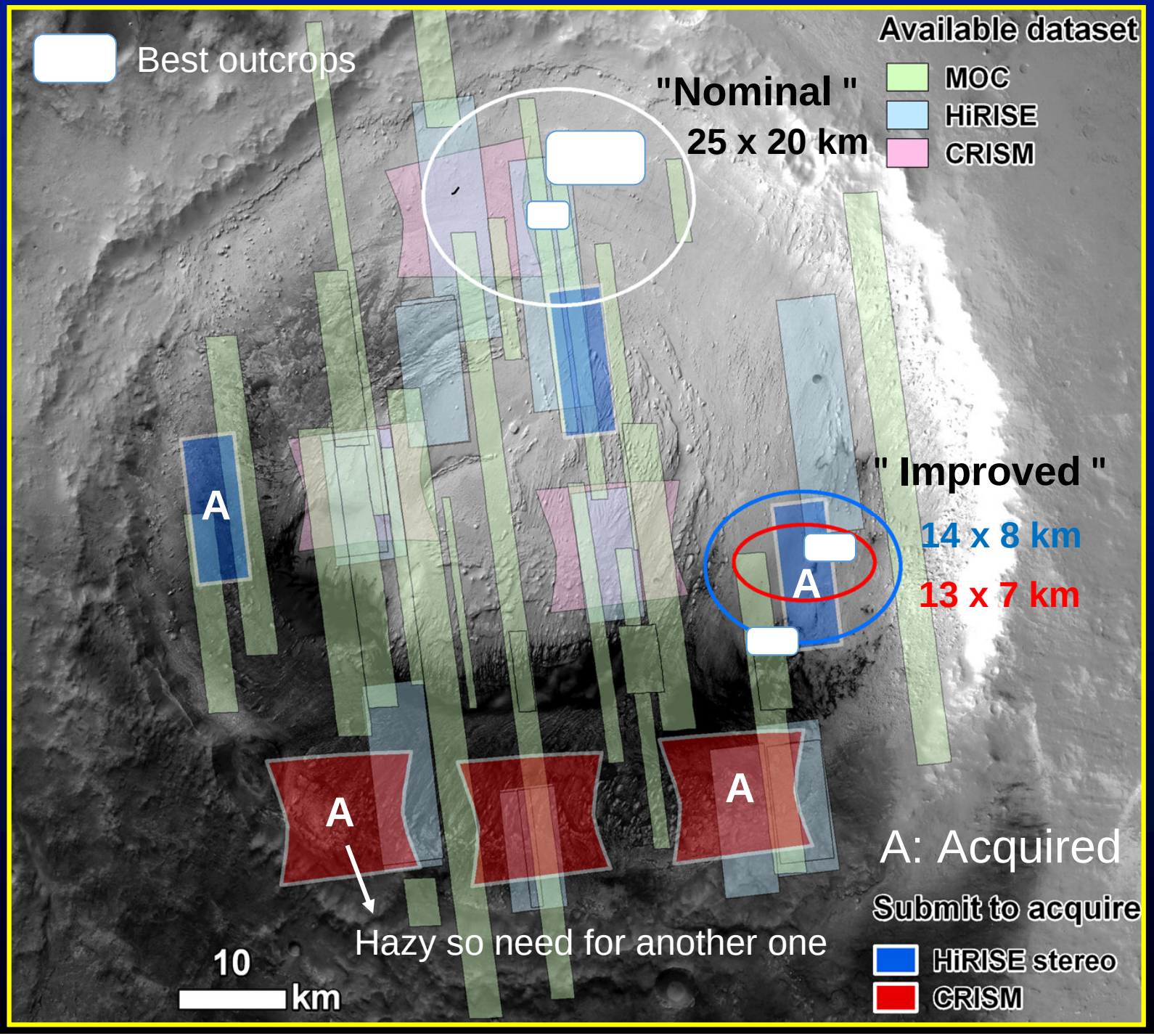


Blue/red ellipses (improved landing ellipse)

Site Name	Firsoff crater
Center Coordinates Latitude, longitude	2.56 °N, 8.94°W
Elevation	-2802 m wrt MOLA
Prime Science and/or Sampling Targets	ELDs (spring deposits) Sulfates
Distance of Science and/ or Sampling Targets from Ellipse Center	Sulfates – 1.8 km to NE Layers – 1.8 km to NE Mounds – 5.3 km to SW

Layers should be few meters thick, but this esteem reflects data from other parts in the crater.
Mounds are more distant than in the 'white ellipse', but 'nicer' (e.g., presence of orifices, lateral continuity with layered unit) at the scale of the possible present observation

Data requests



Conclusive Remarks

- ✓ We propose Firsoff crater as potential Landing Site for the 2020 Mars Rover mission;
- ✓ Firsoff crater shows a well exposed km-thick sedimentary succession made up of light-toned deposits that at least in part consist of sulfates;
- ✓ Morphologies, textures and composition are consistent with a formation by fluid expulsion and evaporite precipitation;
- ✓ Earth analogues to such a setting show evidences of microbial activity;
- ✓ Sulfates have a good potential to preserve life traces.

BACKUP

Relative stratigraphy --> ELDs base

Cratered Unit *(Plateau Sequence)*
(Scott and Tanaka, 1986)

Onlap

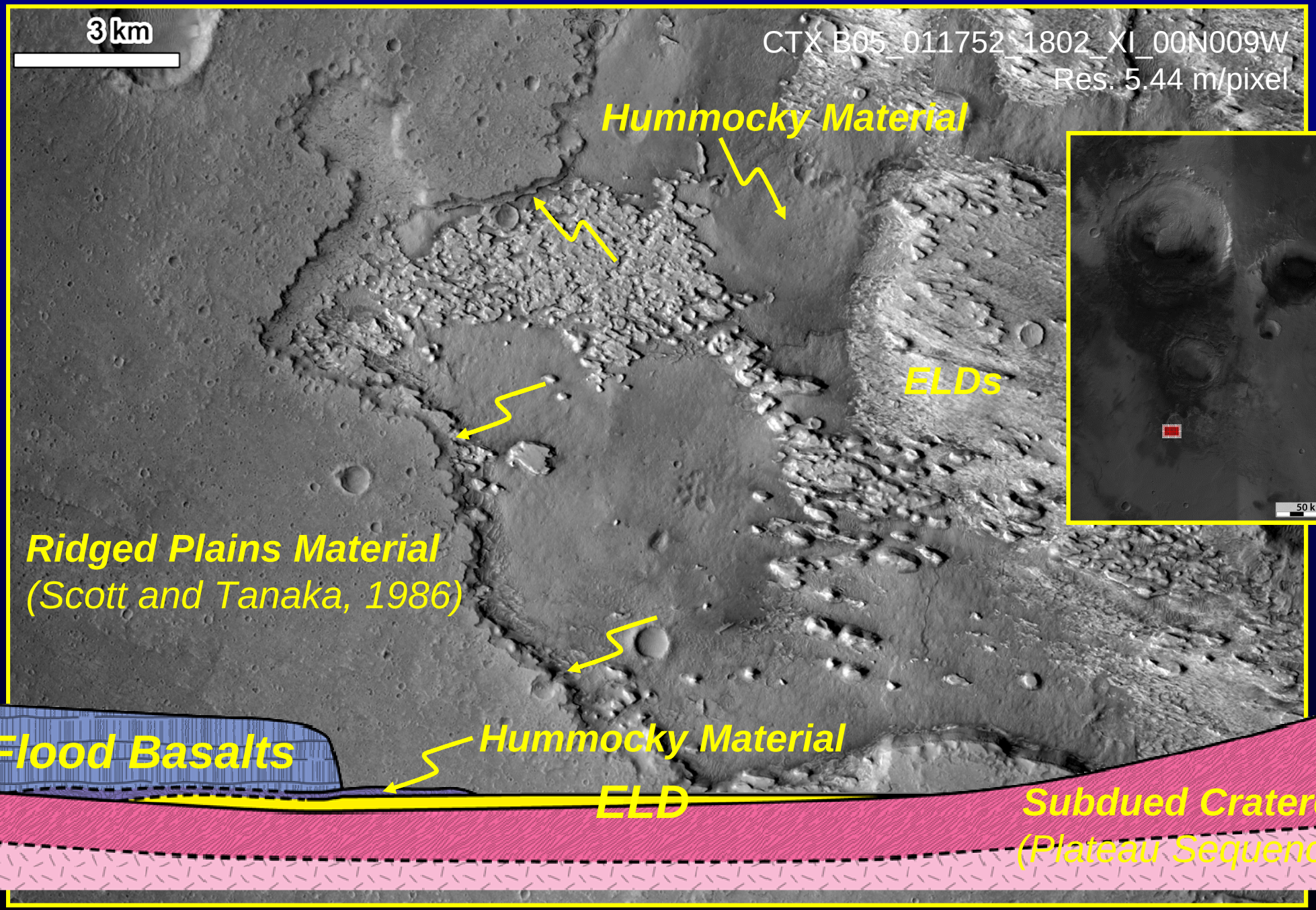
ELDs

Draping

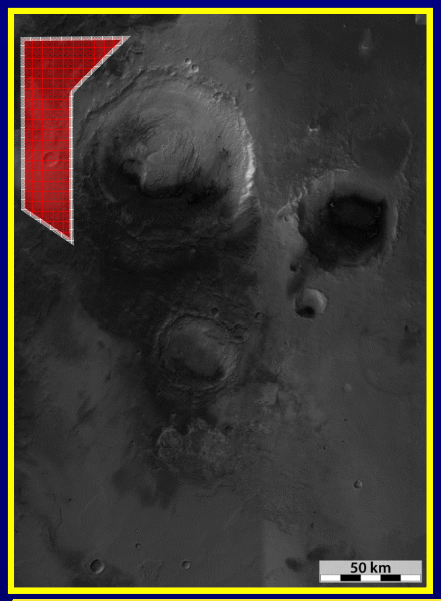
Onlap

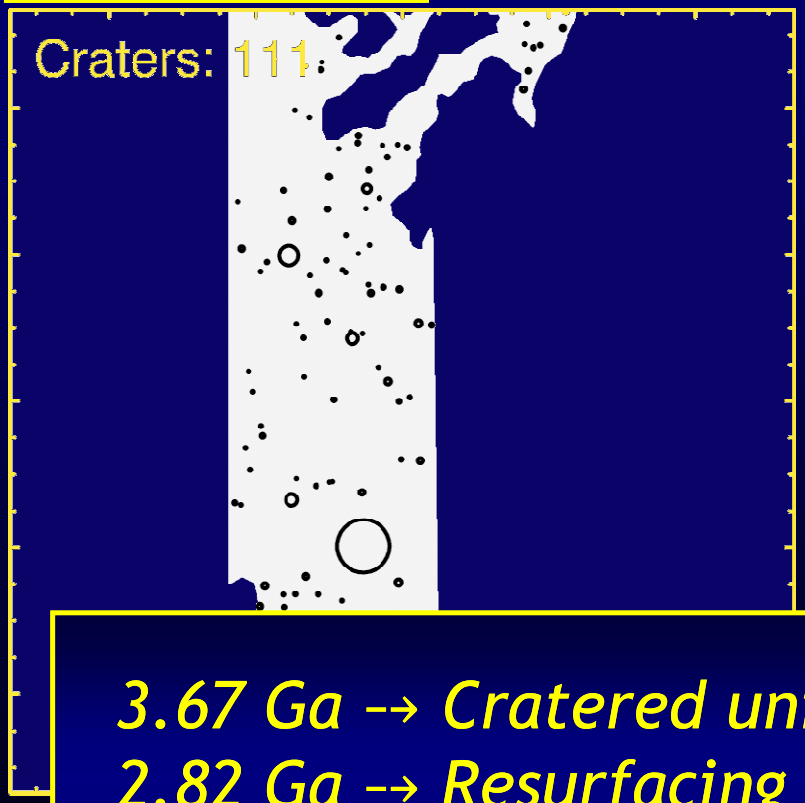
CTX P04_002654_1826_XN_02N010W
draped on HRSC DEM
Vertical exaggeration: 5

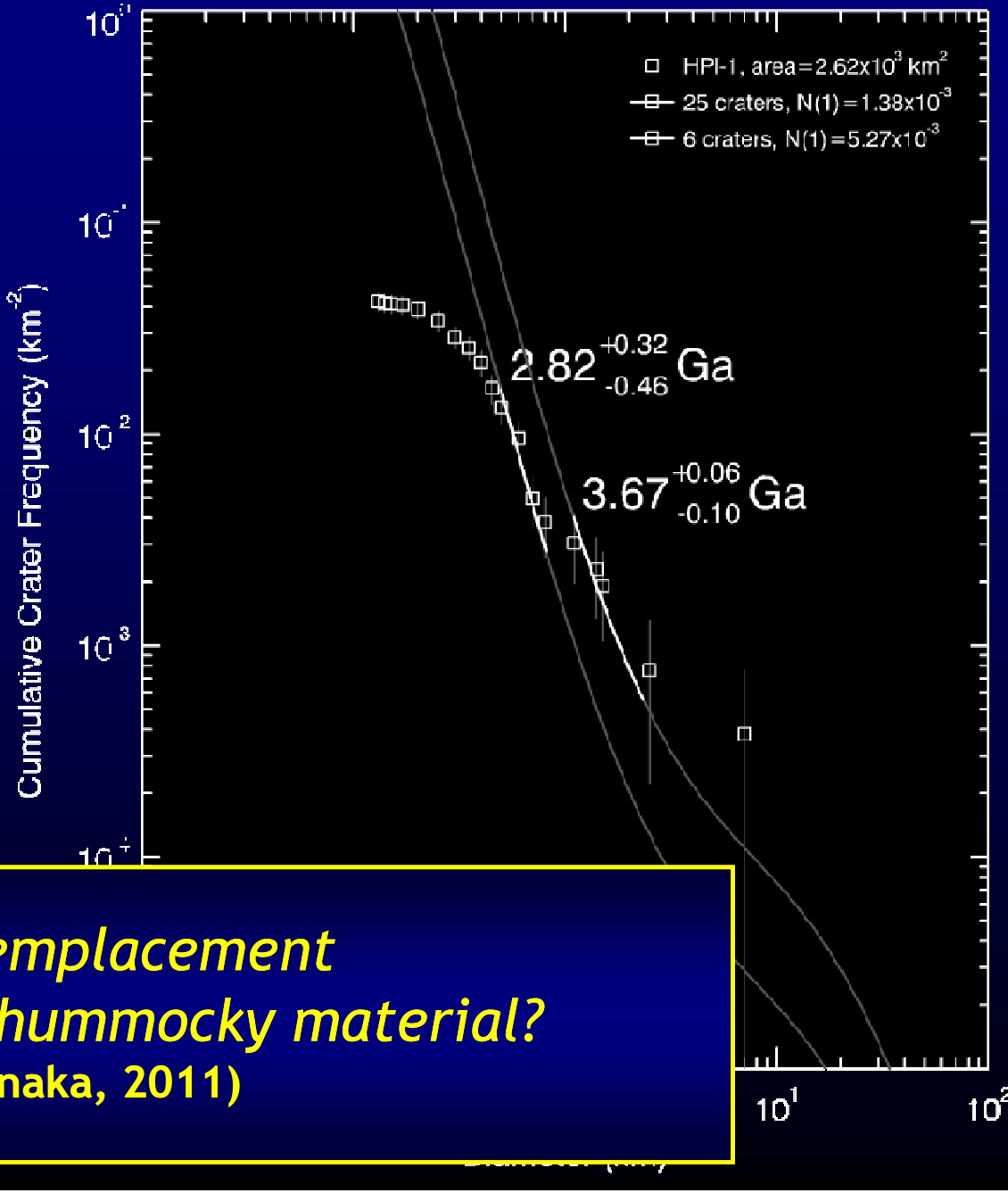
Relative stratigraphy → ELDs top



Crater counting → Cratered unit





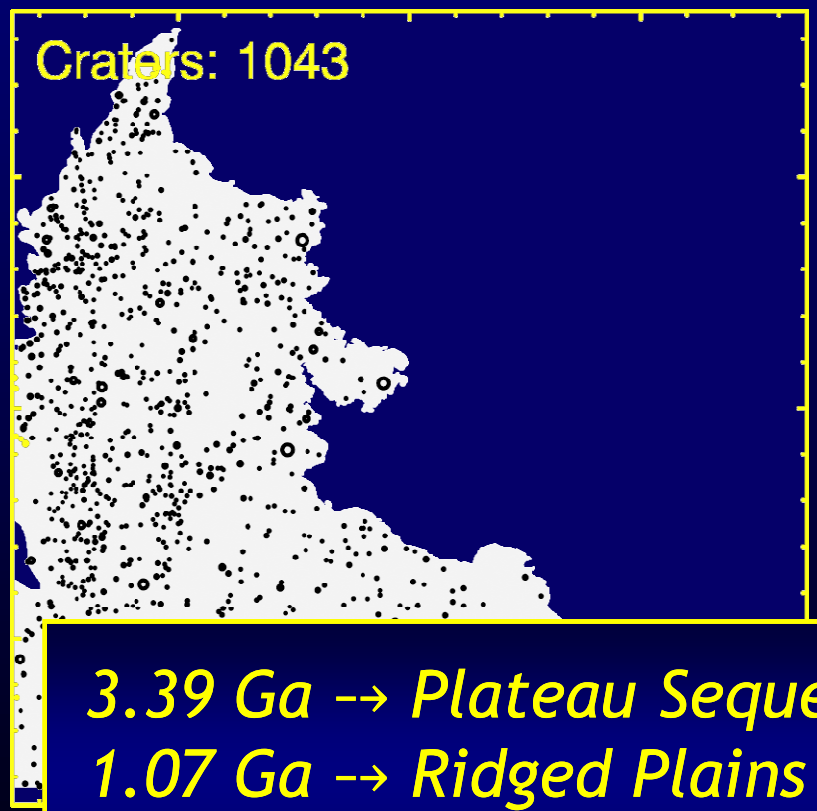


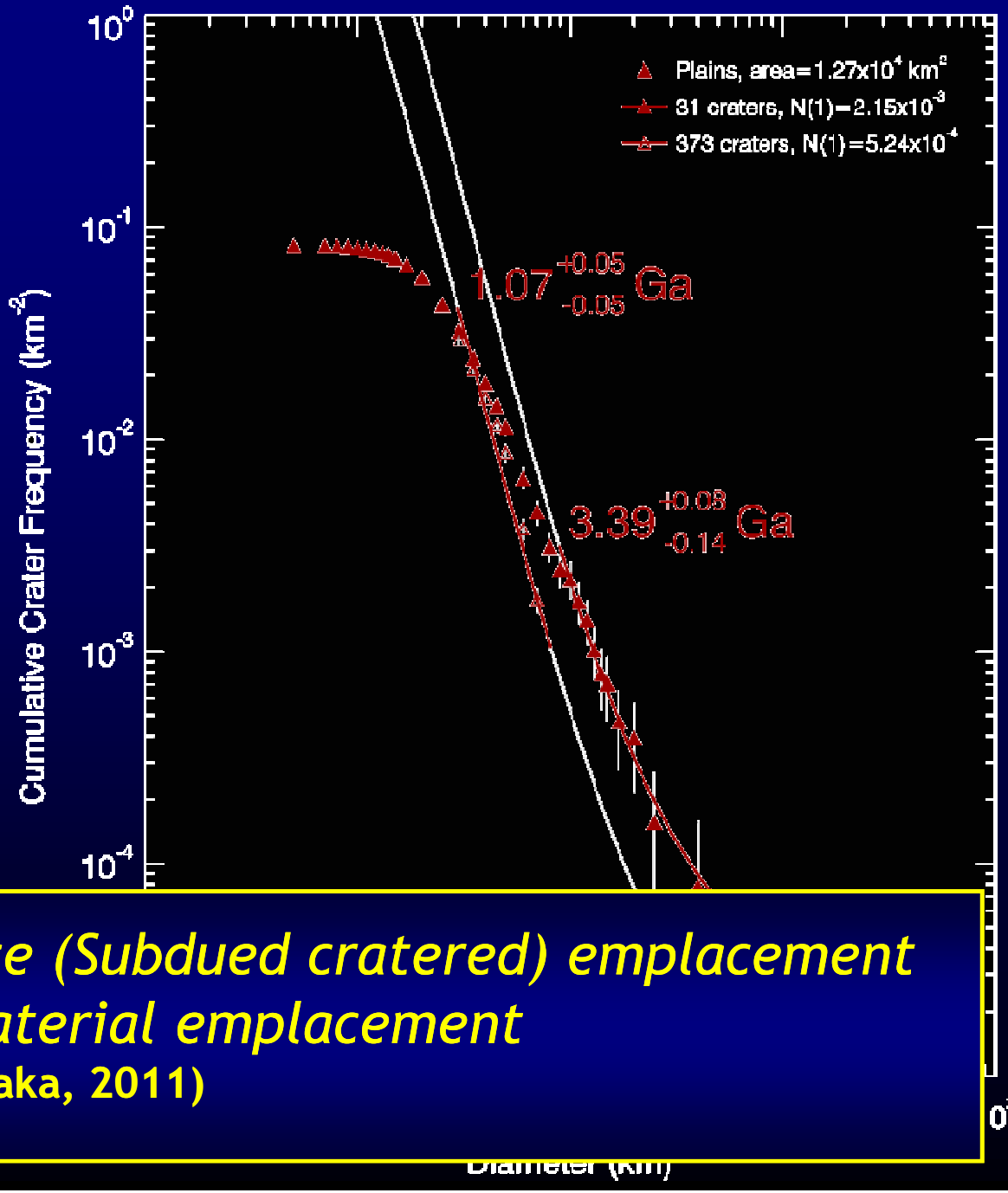
3.67 Ga → Cratered unit emplacement

2.82 Ga → Resurfacing → hummocky material?

(Hartmann, 2005; Werner and Tanaka, 2011)

Crater counting --> Plains





3.39 Ga --> Plateau Sequence (Subdued cratered) emplacement

1.07 Ga --> Ridged Plains Material emplacement

(Hartmann, 2005; Werner and Tanaka, 2011)